Manufacturing

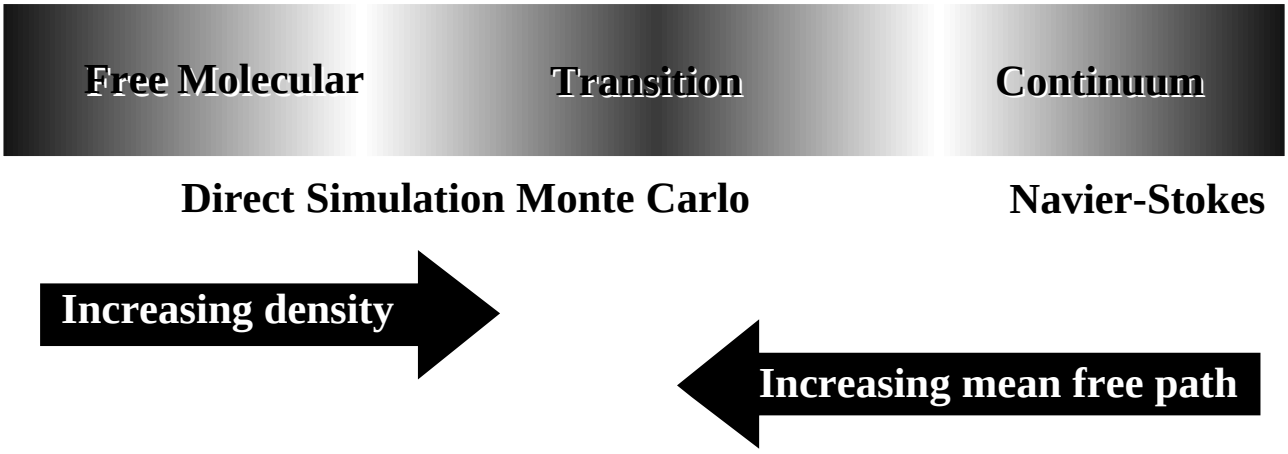
Materials

Technology Opportunity

DSMC: When Conventional CFD is Not Enough

The direct simulation Monte Carlo (DSMC) method is a technique for the computer modeling of a real gas by some thousands to millions of simulated molecules. The method is used primarily for the modeling of low density (rarefied) gases for which the Navier-Stokes equations of computational fluid dynamics (CFD) do not provide a valid model. The computer conducts a direct physical simulation of the fluid problem, rather than solving the system of mathematical equations that model the process. DSMC has been used at the Langley Research Center to study everything from 3-D Shuttle reentry in the upper atmosphere to the details of the interaction between two shocks on a scale of a few thousandths of an inch.

The Calculation of Fluid Flows



Potential Commercial Uses

- Low pressure chemical vapor deposition
- Micromechanical devices, microchannel flow
- Chemical vapor infiltration techniques
- Thin film bearings

Benefits

- Reduce experimental requirements
- Runs on inexpensive personal computers
- More accurate analyses
- Easy to understand and apply

The Technology

The direct simulation Monte Carlo (DSMC) method allows the computational modeling of rarefied gases outside (as well as within) the range of validity of the Navier-Stokes equations of fluid mechanics. The computer follows many thousands or even millions of representative simulated molecules through collisions and boundary interactions in simulated physical space. Solutions for steady and unsteady problems are obtained by averaging over many small time steps.

A flow is considered rarefied when the typical size dimension of the problem is comparable to the mean free path (average distance a molecule travels between collisions) of the molecules in the gas. Thus, DSMC is alternately applicable to flows at very low pressure or to problems with very small charateristic dimensions (i.e. Microelectromechanical devices). The method is also valid for problems of greater density and larger dimensions, but computational time and costs eventually become prohibitive. Recent improvements in computer technology have made calculations that were impossible five years ago routine today. Anticipated improvements in both hardware and software will continue to extend the range of applicability of the method.

Considerable expertise in applying DSMC to complex engineering problems resides at Langley Research Center. Advanced and special purpose DSMC codes are developed, tested and applied here.

Options for Commercialization

The DS2G Two-Dimensional or Axially Symmetric DSMC code executable and user's guide are available without restrictions from the Langley Research Center. This code runs on an IBM PC or PC clone with a 386 processor or better and a minimum 8 Meg RAM. The code comes with 9 demonstration cases which illustrate the range of engineering problems which can be solved using this technique.

Opportunities exist for obtaining or jointly developing more advanced codes to meet commercial requirements. This technology opportunity is part of the NASA Technology Transfer Program. The program seeks to transfer critical technologies to the private sector to ensure that NASA programs will have maximum commercial impact.

Contact

If your company is interested in DSMC, or if you desire additional information, please contact:

Lance B. Bush, Mail Stop 200
NASA Langley Research Center
Hampton, VA 23681-0001
Phone: (804) 864-4514
Fax: (804) 864-8314
E-Mail: l.b.bush@larc.nasa.gov

EMT-101

Key Words

CFD, fluid flow, rarefied gas, low density fluids